Canadian Nuclear Safety Commission
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Cancer and General Mortality in Port Hope 1956 – 1997

By Surveillance and Risk Assessment Division Centre for Chronic Disease Prevention and Control, Publication and Public Health Branch, Health Canada

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Cancer and General Mortality in Port Hope, 1956 – 1997

Abstract

This Health Canada (HC) report responds to public health concerns over environmental exposure to radioactive and other materials in Port Hope that were by-products of radium and uranium processing activities in the town since the 1930s. The study was commissioned by the Canadian Nuclear Safety Commission (CNSC). An ecological study of cancer incidence in Port Hope has already been conducted. The results showed that, compared to cancer incidence in the general population of Ontario, there was no overall evidence of an increased elevation of cancer in Port Hope. Nevertheless, some increases and decreases were observed when the data were examined by time period and for men and women separately.

The objectives of the present report included:

- extending the cancer mortality analysis to an earlier period;
- examining results for cancer and all other major causes of death; and
- comparing the cancer mortality results with the previous cancer incidence report.

The results of this study found no overall evidence of an increased elevation of cancer mortality in Port Hope. For the period 1956 to 1997, there were 836 cancer deaths observed, which was very close to the number expected (845) based on Ontario rates. Significant exposures to radiation would, *a priori*, have been anticipated to increase the mortality from leukemia and perhaps breast and lung cancer. Mortality rates for leukemia and breast cancer were not elevated. Lung cancer mortality was of interest because of the increased incidence observed among women (1986-1996) in the cancer incidence report. For the period 1986-1997, the standardized mortality ratio (SMR) for lung cancer among women was 1.28 (95% CI 0.89-1.77) and among men it was slightly below one. The lack of evidence of elevated lung cancer is reassuring. Further, there was no evidence that childhood leukemia mortality in particular, a known radiation-induced cancer, was increased above expectation. A consistently increased mortality from circulatory disease, including ischemic heart disease, cerebrovascular disease and diseases of the arteries was observed. For the period 1956 to 1997, there were 2,301 circulatory disease deaths observed, an increase of 15% from the 2,000 deaths expected based on Ontario rates. While there were some increases in cancer mortality when data were subdivided into finer units by time period and separately for males and females, the observed patterns were similar to Ontario rates. These findings are, on the whole, consistent with the earlier incidence report and reassuring that the patterns of cancer mortality are comparable to the province of Ontario.

The purpose and limitations of ecological studies must be kept in mind. They describe only the disease occurrence (i.e., the health status) of the community. They are not able to

examine causal relationships between environmental exposure and disease occurrence. Exposure to individuals is not known and no consideration is given to the multiple risk factors of disease, population mobility impacts on environmental exposures or errors known to occur in assigning place of residence. In addition, the precision of the statistics from some causes of death is limited by the small number of deaths. Nonetheless, as there was industrial activity in Port Hope that has increased environmental levels of known carcinogens, albeit at low levels, it would be useful to periodically monitor cancer incidence and mortality in Port Hope using cancer statistics that are routinely collected or with enhanced residence information to learn whether any changes might occur. In addition, disease prevention efforts may be considered in order to reduce the elevated circulatory disease mortality which was also observed in the larger Northumberland County, rather than being limited to Port Hope.

Résumé

Ce rapport de Santé Canada (SC) tente de répondre aux préoccupations en matière de santé publique entourant l'exposition environnementale à des matières radioactives et autres matières, qui sont des sous-produits des activités de transformation du radium et de l'uranium à Port Hope depuis les années 30. L'étude a été commandée par la Commission canadienne de sûreté nucléaire (CCSN). Une étude écologique de l'incidence du cancer à Port Hope a déjà été effectuée. Elle a révélé que comparativement à l'incidence du cancer dans la population générale de l'Ontario, on n'observait pas en général de surincidence du cancer à Port Hope. Certaines augmentations et réductions ont cependant été relevées lorsque les données ont été ventilées par période et pour les hommes et les femmes séparément.

Le présent rapport visait entre autres les objectifs suivants :

- étendre l'analyse de la mortalité par cancer à une période antérieure,
- examiner les résultats pour les décès attribuables au cancer et à toutes les autres causes importantes et
- comparer les résultats relatifs à la mortalité par cancer avec ceux du rapport précédent sur l'incidence du cancer.

La présente étude n'a fait ressortir en général aucune surmortalité par cancer à Port Hope. Pour la période 1956-1997, on a recensé 836 décès par cancer, ce qui est très voisin du nombre prévu (845) d'après les taux ontariens. Des expositions importantes à des rayonnements auraient dû, en principe, accroître la mortalité attribuable à la leucémie et peut-être au cancer du poumon et du sein. Or, les taux de mortalité par leucémie et cancer du sein n'étaient pas plus élevés. La mortalité par cancer du poumon présentait un certain intérêt à cause de la surincidence de ce type de cancer chez les femmes (1986-1996) dans le rapport sur l'incidence du cancer. Pour la période 1986-1997, le rapport standardisé de mortalité (RSM) pour le cancer du poumon chez les femmes s'établissait à 1,28 (IC à 95 % 0,89-1,77) et à un peu moins de un chez les hommes. L'absence de données

indiquant une surincidence du cancer du poumon a de quoi rassurer. Rien n'indiquait non plus que la mortalité due à la leucémie infantile en particulier (cancer connu pour être radio-induit) dépassait les prévisions. On a observé une surmortalité constante attribuable aux maladies de l'appareil circulatoire, notamment aux cardiopathies ischémiques, aux maladies vasculaires cérébrales et aux maladies des artères. Pour la période 1956-1997, 2 301 décès imputables à des maladies de l'appareil circulatoire ont été recensés, soit une augmentation de 15 % par rapport aux 2 000 décès prévus d'après les taux pour l'ensemble de la province. Bien qu'on ait observé certaines hausses de la mortalité par cancer lorsque les données ont été fractionnées en unités plus fines selon la période et pour les hommes et les femmes séparément, les tendances relevées étaient semblables que pour l'Ontario. Ces observations concordent dans l'ensemble avec le rapport antérieur sur l'incidence et contribuent à nous rassurer en nous montrant que les taux de mortalité par cancer chez les résidents de Port Hope et les Ontariens sont comparables.

Il faut garder à l'esprit l'objectif et les limites des études écologiques. Elles ne décrivent que la survenue de maladies dans la collectivité (ou son état de santé). Elles ne permettent pas d'examiner les relations de cause à effet entre l'exposition à des substances dans l'environnement et la survenue de maladies. L'exposition subie par les individus n'est pas connue et les facteurs de risque associés aux maladies ne sont pas considérés, la mobilité de la population influe de plus sur les expositions environnementales, et on sait que des erreurs se produisent dans l'attribution du lieu de résidence; enfin, la précision des statistiques relatives à certaines causes de décès est limitée en raison du petit nombre de décès. Néanmoins, comme Port Hope a connu une activité industrielle associée à des niveaux accrus de cancérigènes dans l'environnement, mais à des doses relativement faibles, il serait utile de surveiller périodiquement l'incidence du cancer et la mortalité par cancer dans cette ville en utilisant les statistiques du cancer qui sont systématiquement recueillies ou de meilleures données sur le lieu de résidence afin de détecter les changements éventuels. En outre, des efforts de prévention de la maladie pourraient être considérés pour réduire la surmortalité attribuable aux maladies de l'appareil circulatoire qui fut observée également à l'échelle du comté de Northumberland, et ne se limite pas à la ville de Port Hope.

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The opinions expressed in this document are those of the authors and do not necessarily reflect those of the Canadian Nuclear Safety Commission

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1. Introduction

1a. Objectives

This Health Canada (HC) report presents an analysis of cancer and general mortality in Port Hope. The study was commissioned by the Canadian Nuclear Safety Commission (CNSC) as a follow-up to an earlier analysis of cancer incidence in Port Hope (ERACS 2000). These two analyses were undertaken because of concern over possible adverse health effects resulting from radioactive waste and heavy metal contamination from radium and uranium refining industries in the town, since the 1930s.

The objectives of the present report included:

- extending the cancer mortality analysis to an earlier period;
- examining results for cancer and all other major causes of death; and
- comparing the cancer mortality results with the previous cancer incidence report.

In conjunction with the toxicological and radiological assessments carried out to date, the current mortality report, in addition to the cancer incidence report, represent a systematic means for evaluation of the health status of the community. This process for addressing public health concerns related to environmental contamination, which involves the toxicological evaluations to predict risk to the community and reviews of health statistics to identify any unusual disease patterns, follows the recommended approach of the U.S. Agency for Toxic Substances and Disease Registry.

This mortality report is a descriptive, ecological study. Because this type of study has limitations, the reader is cautioned in making inferences. Ecological studies are generally used to develop hypotheses, and have as the unit of analysis the population or groups of people, rather than individuals. However, an association observed between variables on an aggregate level does not necessarily mean that the same association will exist at the individual level. Strengths and limitations of ecological studies are described in the Discussion.

1b. Port Hope Background

A plant processing radium and uranium ores has been operating in Port Hope since the 1930s. As a result of concerns about the disposal of low-level radioactive waste in the area and the use of contaminated fill at various construction sites, remedial action was initiated in the 1970s for homes with radon levels above 0.02 WL (about 150 to 185 Bq/m^3). Additionally, operations of a foundry manufacturing ceramics had caused heavy metal soil contamination in several areas of the community. Surveys have been conducted in Port Hope to delineate and evaluate areas of contamination (RWRD 1994, SENES 1995, LLRWMO 1995, Ladouceur 1996).

Lees (1987) conducted a case-control study of lung cancer with 27 eligible cases identified over a 10-year study period, based on residential radon exposure estimates from the first survey used to assess the need for remedial action. While there were no conclusive results linking domestic radiation with lung cancer, a marginally significant association with estimated corrected exposure and a strong association with smoking status was reported. This study had a limited estimated power of 0.28 to detect a relative risk as large as 2.0 because of the small number of cases (Lubin 1990).

In 1994, Health Canada undertook a dose reconstruction project to assess the cumulative radiation exposure to town residents, covering indoor and outdoor exposure to gamma radiation and radon gas, inhalation of airborne uranium, and ingestion of uranium and radium from contaminated soils (SENES 1995). The major contributor to radiation exposure was indoor radon. Based on the cumulative estimated exposures observed and existing knowledge of dose-response relationships of radiation risk, an observable excess of cancer would not be expected because the cumulative doses were low (Tracy 1995, ICRP-60, Boice 1996).

Concern has also been expressed regarding historic airborne deposition of metals such as arsenic, uranium and lead. The Ontario Ministry of the Environment (OME) assessed potential adverse health effects of various metals emitted from this plant and other earlier industrial activities in Port Hope including arsenic, chromium, cadmium and nickel (OME 1991). They reported that levels observed in Port Hope at the time of the report were not of sufficient magnitude to expect increases in cancer. These metals or their compounds are considered human carcinogens by the International Agency for Research on Cancer (IARC). Inhalation in occupational settings has been the principal route of exposure and excess lung and nasal cancers have been reported (IARC 1987). An evaluation of soil from the play areas of 12 Port Hope schools resulted in one area being fenced off because of elevated lead and antimony levels (OMEE 1997, OME 1997).

Two earlier reports of cancer mortality rates indicated that rates in Port Hope were comparable to other areas of the province and the country. In a report of mortality in selected urban areas in Ontario for the period 1954-1978, mortality from 33 causes of death was not significantly different from provincial averages (Ecosystems 1984, Kusiak 1984). The Mortality Atlas of Canada, Volume 3, which covered the period 1973-1979, reported that cancer mortality rates for Port Hope, including Hope Township, were not significantly different from Canadian rates (HWC 1984).

Mortality data for Port Hope and Hope Township (1986-1992) was included in a series of reports prepared for the Great Lakes Health Effects Program of Health Canada (GLHEP 1998). This report also included Hope Township in the study area to try to minimize residence coding errors, since no manual review of residence information on death certificates was conducted. This resulted in Port Hope comprising about 75% of the total population. The mortality summary reported all-age rates were significantly elevated among either men or women for the components of circulatory disease (classified as diseases of pulmonary circulation, other forms of

heart disease, diseases of the arteries, and atherosclerosis), Parkinson's disease, pneumonia and influenza.

1c. Radiation Risk Background

Epidemiologic studies of populations exposed to radiation because of occupational, medical treatments, nuclear reactors and nuclear weapons have linked many cancer sites with radiation exposure. Either relative or absolute scales of risk are used, and the most complete models include the modifying factors of sex, age at exposure and time since exposure. The term relative risk (RR) describes the ratio of cancer rates in an exposed group relative to those in an unexposed group. For example, an RR of 2 corresponds to a doubling of the cancer rate. The term excess risk (ER) describes the increase in cancer rates relative to an unexposed group, but measured on an absolute scale. An ER may be expressed as the extra annual number of cancers per 10,000 persons. If either the RR or ER have been derived from a linear dose-response analysis, they may be expressed as amounts per unit dose, e.g., RR per Sv; otherwise, they may be quoted for a specific dose from the dose-response curve, e.g., at 1 Sv. A model also frequently used for radiation studies presents results based on a model of excess relative risk (ERR) per unit of dose. Table 1 presents a range of RR and ER estimates for various tissues with regard to the carcinogenic influence of radiation (Boice, 1996).

The Life Span Study (atomic bomb survivors) cancer incidence and mortality data demonstrate statistically significant effects of radiation for all solid tumours as a group, as well as stomach, colon, liver, lung, breast, ovary and bladder cancers. The incidence data provide evidence of excess radiation risks for thyroid cancer and non-melanoma skin cancers. An association with radiation exposure is noted for most types of leukemia. Latencies of only a few years have been observed for radiation-related leukemia and it's comparatively large, site-specific risk serves as an early alert for radiation risk (UNSCEAR 2000, Vol. I). Many tumors of solid tissues have latencies of 10 years or more.

Studies of populations exposed to medical, occupational or environmental radiation provide information on issues that cannot be addressed by the atomic bomb survivor data. A combined analysis of data for a large number of nuclear workers indicates that the risk of leukemia increases with increasing dose. Elevated risks of thyroid cancer as a result of the Chernobyl incident show a link with radioactive iodine exposure during childhood. Recent results from several case-control studies of lung cancer and indoor radon are consistent with extrapolations from data on radon-exposed miners (UNSCEAR 2000, Vol. I).

Increased non-cancer mortality and incidence, particularly for circulatory disease, have been reported at doses of the order of one Gy or higher for several of the cohorts also used to investigate the cancer risks associated with radiation. Cellular mechanisms for a relationship between radiation and circulatory disease have been proposed. Studies include patients receiving high radiation doses at high dose rates for treatment of Hodgkin's disease as well as breast cancer, and the Japanese atomic bomb survivors. However, there is some evidence that

risks per unit dose based on groups exposed to high dose rates may overestimate the effects of doses and dose rates related to environmental sources (UNSCEAR 2000, Vol. 1).

A relative risk of 2.56 for acute myocardial infarction (95% CI: 1.11-5.93) was reported for Hodgkin's disease patients treated with acute mediastinal radiation compared to patients with no exposure (Boivin et al, 1992). A study of Stanford University Medical Center patients treated for the same disease reported relative risks for deaths from heart disease after treatment for mediastinal radiation of 4.3 (95% CI: 3.1-5.5) before 1972 and 2.6 (95% CI: 1.7-3.6) after 1972 (Hancock et al, 1993). Shielding limited the radiation dose to the entire cardiac silhouette to 15 Gy after 1972. However, 79% of patients received doses of 40 Gy to the mediastinum. A declining trend in the RR for heart disease with age was observed.

A large study of cancer patients in the U.S. Surveillance, Epidemiology and End-Results (SEER) program reported an overall relative risk of 1.17 (95% CI 1.01-1.36) for fatal myocardial infarction for left- compared to right-sided breast cancer patients after adjuvant radiotherapy, which increased to 1.98 (95% CI 1.31-2.97) for patients less than age 60 (Paszat et al., 1998).

The excess relative risk per Sv reported for non-cancer mortality in the atomic bomb survivors were: stroke (0.09; 90% CI: 0.02-0.17); heart diseases (0.14; 90% CI: 0.05-0.22); respiratory diseases (0.18; 90% CI: 0.06-0.31); and digestive diseases (0.11; 90% CI: 0.00-0.24) (Shimizu et al, 1999). The majority of excess mortality continues to be cancer-related, but the proportion associated with non-cancer mortality has increased with additional follow-up.

2. Methods

The materials and methods used in this report are standard and directly related to the main objective, to compare the mortality in Port Hope with that in the entire province of Ontario. Deaths, from 1950 onward, having a vital statistics residence code of Port Hope, were selected from the Canadian annual mortality file at Statistics Canada. This residence code is based on the municipal name. Addresses for these death certificates were reviewed at Statistics Canada to confirm the residence was within the town boundary in effect for the year in which the death occurred. Port Hope town boundaries expanded in 1956, 1957, 1963 and 1990. Mortality rates from this database for the period 1986-1997 for Hope and Hamilton Townships, located outside the Port Hope town boundaries, were obtained for comparison with Port Hope results, since it was expected some deaths might be incorrectly coded to the town based on previous studies. Mortality rates for Northumberland Census Division (CD), which has included the municipality of Port Hope in recent years, were also available. However, no review of residence information was undertaken for deaths with the original residence code outside Port Hope.

Population data at the municipal level and for the province were obtained for the 1951 through 1996 censuses from the Demography Division of Statistics Canada. These data were not adjusted for the estimated census undercount, since this adjustment was not available on data at the municipal level or lower, or for years before 1971. Populations for intercensal years were estimated by linear interpolation within age groups, separately for males and females. Data were

available for 19 age groups (<1, 1-4, 5-9, ...80-84, 85+) starting with the 1966 census. However, for the 1951, 1956 and 1961 censuses, population data for Port Hope were available for only 11 age groups, with the maximum age group of 70 or more. In addition, data for the 1951 and 1956 censuses were available by age group only for males and females combined. Age-specific population estimates for 1956 were split into estimates for males and females starting from the proportions from the 1961 census in Port Hope and then using Ontario mortality rates for 1956-1960 to estimate the number that would have been alive in 1956 and adjusting the calculated totals by age and for the all-age total for males and females to those of the 1956 census. Because of the additional uncertainties involved in creating 1951 population estimates, results are presented starting from 1956.

Standardized mortality ratios (SMRs) with confidence intervals (CIs) and a test for the trend in the SMR over the period were calculated using provincial rates as the reference (comparison) area. The SMR is defined as the number of deaths observed divided by the number expected, based on sex and age-specific provincial rates for the corresponding period (Breslow 1987a). A value of 1.0 indicates the observed deaths were equal to the expected values based on the Ontario rates. In other reports, it is also common to see the SMR presented after multiplication by 100, so that it is expressed as a percentage. The confidence interval for the SMR is based on the assumption that the number of deaths is approximately Poisson distributed.

Results are presented for three 10-year intervals beginning in 1956 (1956-1965, 1966-1975, 1976-1985), for the 12-year period 1986-1997, and for 1956-1997 (42 years) stratified by the four component periods. In addition to providing further periods for comparison, the importance of going back as early as possible is based on providing results for the time period before remedial actions were initiated to determine if greater effects were observed than in later periods. Starting in the period 1966-1975 corresponded to the availability of the more detailed age data. SMRs are presented for all ages combined and ages 0-19 for childhood cancer. Discussion in the text is included for ages 20-74 as the cause of death coding may be less precise among the oldest age groups.

During the period 1956-1997, four versions of the International Classification of Diseases (ICD) were in use for mortality coding (ICD-6 to ICD-9). ICD-9 cause groupings were used where reasonably equivalent codes were available for the earlier versions of the ICD. The impact on the comparison between Port Hope and Ontario rates should not be greatly affected because the changes in ICD coding should be the same for Port Hope as for all of Ontario. The ICD cause groupings used for cancer were similar to the previous cancer incidence report. The complete list of disease groupings is included in Appendix A. In the tables, titles for diseases presented below an ICD chapter total, which are contained within that disease chapter, are indented and in italics. All cancer combined and radiosensitive sites of cancer were examined first (cancers frequently associated with radiation), then all other causes of death. Tables are presented in ICD order.

Because of confidentiality requirements, the present report restricts reporting to cells of five or more deaths as agreed upon in the data access application made to the Ontario Registrar of Vital Statistics. Since results were also presented for males and females separately and combined, separately by period (1956-1965, 1966-1975, 1976-1985, 1986-1997) and for the combined

period 1966-1997, some of the combined values also had to be suppressed to preserve confidentiality of components with counts less than 5. The significance flags and direction of the SMR are retained in the tables in all cases. Since the geographic regions coincided, results for the standardized incidence ratio (SIR) in Port Hope (1986-1996) from the previous cancer incidence report (based on each of the Ministry of Health residence code and postal code) were compared to the SMR (1986-1997) in this report to evaluate the consistency of the two indicators.

3. Results

3a. Port Hope Residence Assignment

The address review undertaken by Statistics Canada identified deaths outside the town boundaries based on street address, as well as those with addresses mentioning concession, lot, rural route, post office box, and those where the lack of street address made an assignment uncertain. Table 2 presents the distribution of cases by period after the review. Cases with an address containing concession, lot and rural route were excluded from the present analysis as well as those with a specific address indicating the residence was outside the town boundary for the year of death. Since the percentage of cases in these situations was relatively small, the analysis should not be greatly affected. The number of cases considered to be outside the town boundaries was less than 1% before 1986. The number of rural deaths increased starting in 1989, resulting in a 5.4% total (84 deaths) for the 1986-1997 period. This corresponded to the period in which a change in processing of death certificates took place. Manual coding, using all available information on the certificate, was switched to an automated procedure, based on matching the place name. The less than 1% of records with a post office box address, those with a street name which crossed the town boundary but had no street number, and those which were otherwise not classifiable were included in the analysis as town residents.

The all-cause SMRs for men and women combined were significantly low for both Hope Township (TP) for 1986-1997 at 0.59 (199 deaths observed versus 337 expected) and Hamilton TP at 0.58 (403 deaths observed versus 693 expected). These figures do not include the 84 deaths originally coded as having a residence of Port Hope but excluded from the present analysis for Port Hope after the residence review. It is likely that some deaths for residents in these townships were coded to adjacent urban municipalities such as Port Hope, rather than residents of the townships actually experiencing unusually low, all-cause mortality rates. The 1996 population for Port Hope was 11,700, compared to the entire Northumberland CD, with a population of 81,795. All-cause mortality for the CD for 1986-1997 was close to provincial rates, with an SMR of 1.01 (95% CI 0.99-1.04).

3b. Mortality for Cancers Frequently Associated with Radiation and Childhood Cancer

Tables 3a-c present all-age mortality rates for Port Hope for all cancers combined, as well as radiosensitive cancers (lung, breast and leukemia). Thyroid cancer is a radiosensitive site. However, it is rarely fatal and no deaths for this cancer were reported among Port Hope residents. Rates for all cancers and these specific cancers were close to provincial rates. Trends are evaluated formally in a later section, but Tables 3a-c allow an examination of the trend over the four periods when the last entry for each cause (the total period) is excluded. There were no apparent trends in these sentinel (radiosensitive) cancer sites. For the period 1956-1997, there were 836 cancer deaths observed, close to the number expected (845) based on population rates. Lung cancer mortality was also of interest because of the increased incidence observed in the report on cancer incidence. For the period 1986-1997, the SMR for lung cancer among women was 1.28 (95% CI 0.89-1.77) and among men it was slightly below one. While it was not possible to present the 1956-1997 lung cancer total for women in order to avoid residual disclosure for the cell 1956-1965 with less than five deaths, the sum for 1966-1997 was calculated as 53 observed versus 46.1 expected, or a SMR of 1.15 (95% CI 0.86-1.50). Neither of these findings are statistically significant.

Figures 1 and 2 present the trends in the SMRs for lung cancer and female breast cancer, for which the 95% confidence intervals covered the expected values based on provincial rates. Figure 3 presents the trend in the SMR of leukemia among men and women combined along with the CIs and there was no indication of elevated rates. The results for 1956-1965 and 1976-1985 were suppressed because of small numbers of leukemia deaths for the 1976-1985 period, but each of these two SMRs was less than one, as well as for the full study period 1956-1997.

Childhood cancers and leukemia for the age group 0-19 are presented in Table 4. All cancer mortality for each of the periods or for the total observed versus expected deaths for the entire study period was not significantly different. There were 11 deaths for the 42-year period compared with 7.4 expected (SMR 1.48; 95% CI 0.74-2.65), as well as for leukemia with five deaths versus 3.1 expected (SMR 1.63; 95% CI 0.53-3.81). For the remaining sites, less than five deaths occurred, not significantly different from the number of deaths expected based on provincial rates.

3c. Other Causes of Death

Tables 5a-c summarize the rates by period for all causes and for disease groupings with significant elevations in the number of deaths for Port Hope in any period, excluding an elevation in one period for motor vehicle traffic accidents (MVTA) because of space limitations. All-cause mortality was elevated in all except the first period among men, but only in the most recent period for women. Over the full study period, the all-cause SMR among men was 1.10 (95% CI 1.06-1.15) and among women was 1.06 (95% CI 1.01-1.10).

During the period 1986-1997, eight deaths from brain cancer were observed among women with Port Hope residence compared to 3.3 expected (SMR 2.39; 95% CI 1.03-4.67). Circulatory

disease, a major component of all-cause mortality, was elevated in all except the first period among men, but was significantly elevated only in the most recent period for women. Over the full study period, the SMR for circulatory disease among men was 1.17 (95% CI 1.10-1.24) and among women was 1.13 (95% CI 1.07-1.20). Figure 4 illustrates the increases by period. Components of this disease category (ICD chapter) include ischemic heart disease, cerebrovascular disease and diseases of the arteries. In Northumberland CD (1986-1997), there were 3,606 circulatory disease deaths (SMR 1.11; 95% CI 1.07-1.14). With 716 deaths in Port Hope for the period (Table 5c), the SMR for the CD excluding Port Hope was 1.07 (95% CI 1.03-1.11). In the respiratory disease chapter, an excess of pneumonia was observed among women starting in the 1976-1985 period (29 deaths versus 18.2 expected; SMR 1.59; 95% CI 1.07-2.28). This excess continued for the 1986-1997 period for both men and women with 77 deaths compared to 52.9 expected (SMR 1.46; 95% CI 1.15-1.82). During the 1976-1985 period, there were 15 cirrhosis deaths among men compared to 8.1 expected (SMR 1.86; 95% CI 1.04-3.07), but no excess was observed in the most recent period.

Tables 6a-c present the SMR for the full list of causes, for the full study period (1956-1997), with a test for trend over period. In a few cases, the period 1966-1997 is presented to avoid disclosure of a period with a small number of deaths. This table also contains the full-period results for causes in Tables 5a-c, so the increased mortality for circulatory disease and pneumonia is again observed. Lower-than-expected mortality was observed among men and women combined for diabetes (SMR 0.55; 95% CI 0.39-0.74) and Alzheimer's disease (SMR 0.59; 95% CI 0.37-0.89). Among diseases with more than 20 deaths in the period with the highest SMR, only diseases of the arteries showed a significant increased trend in both men and women separately, but all causes and all circulatory diseases showed an increased trend among men and women combined.

3d. Mortality Rates Ages 20-74 or Ages 20-69 (1956-1965)

The set of corresponding tables for these age ranges is not presented because it did not add substantially to the report. Additional disease groupings for ages 20-69 with significantly-elevated mortality not mentioned above, included all cancer for men (45 deaths, SMR 1.38; 95% CI 1.00-1.84) and non-Hodgkin's lymphoma among women (less than five deaths). In the age group 20-74, 18 colorectal cancer deaths were reported among women for the period 1986-1997 (SMR 1.82; 95% CI 1.08-2.88). The SMR for lung cancer mortality (1986-1997) among women also indicated a higher value for this truncated age group than for all ages combined (SMR 1.48; 95% CI 0.98-2.16).

3e. Comparison of Incidence and Mortality

Tables 7a-b compare standardized incidence ratios (SIRs) in Port Hope (1986-1996) from the previous cancer incidence report, using postal codes to assign residence, with the SMRs (1986-1997) from the present report. The results are generally consistent. Lung cancer has a poor prognosis and therefore results based on incidence and mortality are expected to be similar. SIRs and SMRs were 1.05 (95% CI 0.80-1.36) and 0.96 (95% CI 0.71-1.27) respectively among men

and 1.35 (95% CI 0.98-1.81) and 1.28 (95% CI 0.89-1.77) among women. None of these ratios was significantly elevated. Since SMRs were not elevated for lung cancer in any of the earlier time periods, it is unlikely the SIRs were elevated. Among women, the SIR for brain cancer, based on the postal code, at 1.61 (95% CI 0.70-3.15) was lower than that based on mortality at 2.39 (95% CI 1.03-4.67). However, the SIR using the Ministry of Health (MOH) residence code was closer at 2.21 (95% CI 1.11-3.94). Brain cancer mortality was not significantly elevated in any other time period, or among men. In comparison to the earlier cancer incidence report, the residence for mortality was reviewed and therefore should be the most accurate, but this review did not contain information on moves following the diagnosis.

4. Discussion

4a. Summary of Main Results

The mortality rates for all cancers were within expected values, based on provincial rates, for all periods examined and among both males and females. As well, no excess rates in 'sentinel' cancers for radiation-based exposures were observed (lung, breast, thyroid and leukemia) for the full 1956-1997 study period, including the earlier periods before the remedial action. Results for these cancer sites are important in examining possible adverse health effects of industrial activity in Port Hope. For the period 1956-1997, there was no significant increase in childhood cancer, including leukemia, with five deaths versus 3.1 expected (SMR 1.63; 95% CI 0.53-3.81). For children, the issues of latency, mobility and the resulting misclassification are less of a problem, thus strengthening the results. Nevertheless, the statistical power for childhood cancer is limited because of the small number of deaths.

A consistently-increased mortality from circulatory disease, including ischemic heart disease, cerebrovascular disease and diseases of the arteries, was observed. For the period 1956-1997, there were 2,301 circulatory deaths observed, 15% higher than the number expected (2,000), based on Ontario rates. All circulatory disease showed a significant increasing trend among men and women combined, and diseases of the arteries showed a significant increase in both men and women separately.

Results presented here for cancer mortality are consistent with the cancer incidence report. Cancer incidence results should be reflected in cancer mortality after allowing for site-specific cancer survival rates. The incidence data is considered superior because the information is recorded at the time of diagnosis and includes access to the pathology report. However, no review of the residence information from the incidence records was carried out.

4b. Strengths and Limitations of the Report

The Vital Statistics data allow a comparison of the Port Hope mortality rate to provincial rates, but interpretation of this report must take into account that it is an ecological study. Advantages of this approach include obtaining results for all causes of death to determine the health status of the community, without the additional cost and difficulties of assembling identifying information on all town residents since 1956 and conducting record linkage of such a residence cohort. The results of this report also allow the feasibility of a case-control or cohort study to be better evaluated. The ecological design has several limitations, including a lack of information regarding cumulative personal exposure to radiation levels, chemical contaminants, cigarette smoking and other primary risk factors both for Port Hope and Ontario. Ecological studies of diseases associated with smoking have a substantial potential for bias (Morgenstern 1995, NRC 1999) and the problem becomes more severe with increasing strength of the risk factor. Mortality data is less useful for diseases with good survival since there is time for individuals to move residence (migration) between diagnosis and death, and information on the diagnosis may be limited, leading to errors in coding the cause of death. On the other hand, registration is simplified as only one source of data is involved.

Misclassification from migration or incorrect residence assignment, if random, would result in a bias towards a null result. Mobility would have an obvious impact. Since all people living in an area at a given time are treated the same, with a person living one year in a community counted in the same way as persons living there 50 years, obvious differences in cumulative exposures can exist. The 1991 census reported 25.3% of Ontario residents living in a different census subdivision (municipality) than five years earlier compared to 28.0% of Port Hope residents (Statistics Canada 1993a). For Ontario, the percentage of persons who lived in a different municipality five years before decreased to 11.1% among persons age 65 or more (Statistics Canada 1993b). Such provincial values were similar for earlier censuses, and slightly lower by 1961 (Statistics Canada 1973).

Kleinbaum (1982) presents a more general discussion of the effects of misclassification, but a non-differential misclassification as a result of equal in- and out-migration can be described in terms of a weighted average. If it is assumed that the true relative risk is 2.0, then if 28% of persons migrated within five years and experienced a relative risk of 1.0, then the observed RR is the weighted average of the two groups and the observed relative risk would be 1.72. Similarly, if 25% of persons moved within each of two five-year periods, and it was assumed only the 56.25% of persons remaining after 10 years experienced the true RR, then the observed value would be reduced to 1.56. In reality, the exposure situation is more complex and, after a certain period, migrants into the area in this scenario may experience increased risk.

While patterns of mortality were not unusual, a few specific cancer types in specific periods or age groups had rates that were significantly different from provincial rates. On average, one in 20 risk estimates (5%) will show a statistically significant increase or decrease in risk by chance alone (i.e., because of random variation) when using a 95% significance level. Although not all

disease groupings are completely statistically independent, men and women in Port Hope each had about 25 disease groupings with at least five deaths for period-specific analyses, allowing for at least marginally stable rate estimates. Thus, when calculating rates for Port Hope for about 25 diseases, for men and women separately, one would expect on average to see two to three causes in each period examined to have a statistically significant increase or decrease in risk by chance alone. Such situations are termed false positives. Over the four periods 1956-1965 through to 1986-1997 respectively, there were 0, 5, 6 and 12 disease groupings significantly elevated and 0, 2, 4 and 3 significantly decreased. About 10 cases expected were required in the community to detect a two-fold increase in relative risk with a probability of 80% (study power) (Breslow 1987b). In such a situation, the probability of a false negative would be the complement, or 20%.

In addition to chance differences in cancer rates observed in the community, differences could also occur if local lifestyle factors or environmental factors in the communities affect rates by differing from provincial averages. It is difficult, however, to determine when it is chance or other factors such as lifestyle or environment that result in significant differences in rates, particularly on the basis of a snapshot view of cancer rates alone for one period in a community. The increased mortality observed for esophageal cancer, colorectal cancer, circulatory disease and cirrhosis suggests the possibility of some common lifestyle risk factors.

4c. Confounding Risk Factors

For males, seven deaths from esophageal cancer occurred compared to 2.8 expected for the period 1976-1985 and the SMR was greater than 1.0 in the previous period, but not the most recent period. The primary risk factors for esophageal cancer in Europe and North America include tobacco products and alcohol (Muñoz 1996).

The eight deaths from brain cancer observed among women for the period 1986-1997 was significantly elevated at the 0.05 level (SMR of 2.39). The corresponding SIR of 1.61 in the cancer incidence report for the period 1986-1996 based on the postal code was lower, while the SIR using the MOH residence code was closer at 2.21. The postal code is more precise, but coding errors can also occur for the postal code. Increased mortality for brain cancer was not observed in the previous period 1976-1985, or among men. The causes of most brain/nervous system cancers are not known. Increased risks have been reported in some cohorts of petrochemical, rubber and agricultural workers, for head trauma, high exposures to radiation from early dental x-rays (1940s), and other medical treatments using radiotherapy. A role for n-nitroso compounds primarily in the diet has been hypothesized and tobacco, including environmental tobacco smoke, also has a role (Preston-Martin 1996). Ionizing radiation can induce brain/nervous system tumors, although the relationship is not as strong as for many other tumors, and most of the observed radiation-associated tumors are benign. Neurilemmomas, which are highly curable, are the only tumors that consistently exhibit high risks of incidence. Overall, exposure during childhood appears to be more effective in tumor induction than adult exposure, but the data on adult exposure are sparse, and the most recent study of atomic bomb survivors demonstrated an excess risk of neurilemmomas following exposure at all ages. The

association between benign tumors, particularly meningiomas and neurilemmomas, and radiation appears to be substantially stronger than with malignant tumors. Malignant brain tumors are seen only after radiotherapy (UNSCEAR 2000, Vol. II). However, the levels of radiation in Port Hope are in orders of magnitude less than those associated with these medical treatments.

Excess mortality among women aged 20-74 was observed for colorectal cancer during the period 1986-1997. The SMR for all ages combined of 1.38 was similar to the SIR observed for cancer incidence for the corresponding period. Risk factors for colorectal cancer include high dietary fat and meat intake and low intake of fibre, fruit and vegetables (Potter 1993). It has been recommended that a provincial cancer-screening program for colorectal cancer be developed and introduced (Cancer Care Ontario, 1999).

The primary risk factor for lung cancer is tobacco smoking with other risk factors including occupational level exposures to radon, arsenic, chromium, polycyclic hydrocarbons, and chloromethyl ethers (Blot 1996). Evidence from studies of residential radon have been considered consistent with extrapolations from the higher levels observed in occupational studies. The fact that results of residential studies conducted to date have been somewhat equivocal may be the result of difficulties in studying the relatively-low relative risks (NRC 1999). Based on occupational studies, it is well established that indoor radon exposure can cause lung cancer and radon was the main source of radiation exposure in the Port Hope population. However, a Health Canada and SENES Consultants Limited report, using estimates of the known radon exposures in Port Hope and the known lung cancer risk coefficient from uranium miners and residential studies, reported a possible excess of five cancer cases, primarily lung cancer, in Port Hope over almost 40 years, starting in 1955 (Tracy 1995). An earlier study of lung cancer in Port Hope (Lees 1987) reported a strong correlation (confounding) between exposure in a 'problem' home (greater than the background level of 60 Bq/m^3) and smoking, and also a strong relative risk for smoking.

When examining causes of death other than cancer, a pattern of increased mortality from circulatory disease relative to provincial rates was noted, especially for the most recent period. This appeared to apply to the ICD component sub-chapters including ischemic heart disease, cerebrovascular disease and diseases of the arteries. Circulatory disease is the number one cause of death in Canada (Heart and Stroke Foundation of Canada, 1999). Main risk factors include cigarette smoking, high blood pressure, high-fat diet, lack of exercise, obesity, high alcohol consumption, cholesterol, diabetes and family history. Based on national hospital morbidity data, up to one-half the excess mortality associated with pneumonia is expected to be related to circulatory disease and chronic obstructive lung disease. Excess mortality from cardiovascular disease was identified following medical procedures that resulted in the heart receiving high doses at high dose rates, including treatment of Hodgkin's disease and breast cancer (Feher 1965, Host 1986, McReynolds 1976, Pearson 1958, Prentice 1965, Tracy 1974). Concrete information at low doses, like those found in Port Hope, is not available. Maximum doses in Port Hope are less than one thousandth of those reported with excess cardiovascular disease. The results for the Northumberland CD as a whole indicated increased circulatory disease mortality rates were not

specific to Port Hope, and in conjunction with the radiation levels, that it was unlikely the increased rates in Port Hope were pollution-related.

4d. Concluding Remarks

This review shows that the numbers of total cancer deaths in Port Hope were within the expected values calculated by applying the provincial rates. The absence of an increase in leukemia rates, and other radiosensitive sites, does not support the hypothesis that radiation exposures in the community impact on residents' health. The absence of excess leukemia cancer rates among children is particularly reassuring, because the minimum latency for childhood leukemia is short and the radiation risk coefficients relatively high. The lack of significantly-elevated mortality rates in the earlier time periods provides additional reassurance because these rates precede remediation and include persons who were possibly exposed at higher dose levels.

While there were some increases in cancer mortality when data were subdivided by time period and sex, the observed patterns were similar to Ontario rates. These findings are, on the whole, consistent with the earlier incidence report (ERACS 2000) and previous mortality and incidence reports (Ecosystems 1984, Kusiak 1984, HWC 1984, GLHEP 1998) and are reassuring that the patterns of cancer mortality are comparable to the province of Ontario. This pattern is consistent with existing knowledge of dose-response relationships of radiation risk that an observable excess of cancer would not be expected because the cumulative doses in Port Hope were low (Tracy 1995, ICRP-60, Boice 1996).

A pattern of increased mortality from circulatory disease relative to provincial rates was noted, especially for the most recent period. This appeared to apply to the component sub-chapters including ischemic heart disease, cerebrovascular disease and diseases of the arteries. Similar findings were noted for the Port Hope and Hope Township 1986-1992 (GLHEP 1998). However, the results for the Northumberland CD as a whole indicated increased circulatory disease mortality rates were not likely to be specific to Port Hope, and in conjunction with the radiation levels, it is unlikely the increased rates were the result of Port Hope's environmental factors.

The only result from the point of view of possible adverse effects of radiation or heavy metal contamination is the excess of brain cancer among women. This was observed in both mortality and incidence (using the MOH code). However, because of the small number of deaths, the confidence interval is wide. There is one result which supports the significance of brain cancer results in terms of the potential role of environmental factors in Port Hope, and other results which do not support the significance. For the incidence results, if the three cases diagnosed during 1986-1996 with residence postal codes outside the town have correct values, then an excess remains of about three cases among women in the town, within the variation expected. The lack of any excess among men in any period does not provide support for an environmental hypothesis. On the other hand, the cancer incidence results using the MOH code among women for the entire 1971-1996 period, results in an excess of about 10 cases and a higher degree of

consistency. The residence of these cases has not been confirmed, and it would probably be difficult to obtain residence information from the physician, obtain permission to contact the patient or next of kin, and locate the cases or the next of kin if required. There is a correlation between incidence and mortality, and some migration to the central town following diagnosis is possible. The excess mortality for brain cancer was observed only among women and in the most recent period. As a result, the observed excess for brain cancer mortality may be a combination of the issue of residence at diagnosis and other risk factors.

The purpose and limitations of ecological studies must be kept in mind, however, as they can only paint with a broad brush the possibility that environmental exposures have affected disease occurrence in a community. Exposure to individuals is not known, population mobility impacts on environmental exposures, and errors are known to occur in assigning place of residence. Nonetheless, as there was industrial activity in Port Hope that has increased environmental levels of known carcinogens, albeit at low levels, it would be useful to periodically monitor cancer incidence and general mortality in the Port Hope community with statistics that are routinely collected or with enhanced residence information to learn whether any changes might occur. Results from the Canadian Community Health Survey (CCHS) will be released shortly by Statistics Canada (Béland 2002) and will provide more information on health determinants and health status at a health region level. However, conducting further analytic studies, such as a case-control investigation of certain cancer types, would not seem a useful exercise based on the findings presented in this report, the previous cancer incidence report, and other cancer incidence and mortality studies conducted in Port Hope.

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List of Acronyms and Units

ASMR - Age Standardized Mortality Rate
Bq - Becquerel
CCDPC - Centre for Chronic Disease Prevention and Control (Health Canada)
CCHS – Canadian Community Health Survey
CD - Census Division
CI - Confidence Interval
CNSC – Canadian Nuclear Safety Commission
ER - Excess Risk
ERR - Excess Relative Risk
Gy - Gray
HC – Health Canada
ICD-9 - International Classification of Diseases, 9th revision
MOE – Ministry of the Environment (Ontario)
MOH - Ministry of Health (Ontario)
MVTA - Motor Vehicle Traffic Accident
PY - Person Year
RR - Relative Risk
SIR - Standardized Incidence Ratio
SGC - Standard Geographic Code
SMR - Standardized Mortality Ratio (observed deaths divided by expected)
Sv - Sievert
TP - Township

Tables

1. Cancers Frequently Associated with Radiation and Range of Risk Estimates

2. Results of Residence Validation, Port Hope 1956-1997, Number of Deaths (Percent)

3a. Cancer Mortality for Males in Port Hope by Period, Cancer Sites of *a priori* interest, All Ages

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5a. Mortality for Males in Port Hope by Period, All Causes and Causes Significantly Different from Province, All Ages

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6a. Mortality in Port Hope, Males, 1956 to 1997

6b. Mortality in Port Hope, Females, 1956 to 1997

6c. Mortality in Port Hope, Males and Females, 1956 to 1997

7a. Incidence and Mortality for Males in Port Hope, All Cancers and Sites Significantly Different from Province in Recent Period, All Ages

7b. Incidence and Mortality for Females in Port Hope, All Cancers and Sites Significantly Different from Province in Recent Period, All Ages

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1. Lung Cancer Mortality in Port Hope by Period, Males and Females, SMR with 95% CI

2. Breast Cancer Mortality in Port Hope by Period, Females, SMR with 95% CI

3. Leukemia Mortality in Port Hope by Period, Males and Females, SMR with 95% CI

4. Circulatory Disease Mortality in Port Hope by Period, Males and Females, SMR with 95% CI

Appendix A

Cancer Site and Other Disease Definitions

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Appendix A. Cancer Site and Other Disease Definitions

ICD-9 Code, Abbreviated Title, and Full Descriptive Title for Individual Cancer Sites

ICD-9 Code	Abbreviated Title	Full Descriptive Title
140-208	**All Cancer Sites**	**All Malignant Neoplasms**
140	Lip	Malignant Neoplasm of Lip
141,143-146 148-149	Tongue and Mouth	Malignant Neoplasm of Tongue, Gum, Mouth, Pharynx ex. Nasopharynx
142	Salivary Gland	Malignant Neoplasm of Major Salivary Glands
147	Nasopharynx	Malignant Neoplasm of Nasopharynx
150	Esophagus	Malignant Neoplasm of Esophagus
151	Stomach	Malignant Neoplasm of Stomach
152	Small Intestine	Malignant Neoplasm of Small Intestine, including Duodenum
153-154,159.0	Colon and Rectum	Malignant Neoplasm of Colon, Rectum, Rectosigmoid Junction and Anus
155.0, .1	Liver	Malignant Neoplasm of Liver and Intrahepatic Bile Ducts
156	Gallbladder	Malignant Neoplasm of Gallbladder and Extrahepatic Bile Ducts
157	Pancreas	Malignant Neoplasm of Pancreas
158	Peritoneum	Malignant Neoplasm of Retroperitoneum and Peritoneum
160	Nose, Sinuses	Malignant Neoplasm of Nasal Cavities, Middle Ear and Accessory Sinuses
161	Larynx	Malignant Neoplasm of Larynx
162	Lung	Malignant Neoplasm of Trachea, Bronchus and Lung
163	Pleura	Malignant Neoplasm of Pleura (equivalent code available 1958 on only)
164	Other Thoracic Organs	Malignant Neoplasm of Thymus, Heart and Mediastinum (equivalent code available 1958 on only)
170	Bone	Malignant Neoplasm of Bone and Articular Cartilage

171	Connective Tissue	Malignant Neoplasm of Connective and Other Soft Tissue
172	Melanoma of Skin	Malignant Neoplasm of Skin
173	Other Skin	Other Malignant Neoplasm of Skin
174	Female Breast	Malignant Neoplasm of Female Breast
175	Male Breast	Malignant Neoplasm of Male Breast
180	Cervix Uteri	Malignant Neoplasm of Cervix Uteri
179, 181-182	Uterus excluding Cervix	Malignant Neoplasm of Uterus (Part Unspecified), Body of Uterus and Placenta
183	Ovary	Malignant Neoplasm of Ovary and Other Uterine Adnexa
184	Other Female Genital	Malignant Neoplasm of Other and Unspecified Female Genital Organs
185	Prostate	Malignant Neoplasm of Prostate
186	Testis	Malignant Neoplasm of Testis
187	Other Male Genital	Malignant Neoplasm of Penis and Other Male Genital Organs
188	Bladder	Malignant Neoplasm of Bladder
189	Kidney	Malignant Neoplasm of Kidney and Other and Unspecified Urinary Organs
190	Eye	Malignant Neoplasm of Eye
191-192	Nervous System	Malignant Neoplasm of Brain and Other and Unspecified Parts of Nervous System
193	Thyroid	Malignant Neoplasm of Thyroid Gland
194	Other Endocrine	Malignant Neoplasm of Other Endocrine Glands and Related Structures
195-199	Ill-Defined and Unknown	Malignant Neoplasm of Other and Ill-Defined, Secondary, and Unspecified Sites
201	Hodgkin's Disease	Hodgkin's Disease
200, 202	Non-Hodgkin's Lymphoma	Lymphosarcoma, Reticulosarcoma, and Other Malignant Neoplasm of Lymphoid and Histiocytic Tissue
203	Multiple Myeloma	Multiple Myeloma and Immunoproliferative Neoplasm
204-208 ex. 207.1	Leukemia	Lymphoid, Myeloid, Monocytic, and Other Specified Leukemia and Leukemia of Unspecified Cell Type

World Health Organization, Manual of the International Statistical Classification of Diseases, Injuries and Causes of Death, Vol. 1 (Tabular List) and Vol. II (Index), 1975 Revision. WHO, Geneva, 1977.

ICD-9 Code, Abbreviated Title, and Full Descriptive Title for Disease Groupings Other than Cancer

ICD-9 Code	Abbreviated Title	Full Descriptive Title
001-999	**All Causes**	**All Causes of Death**
001-139	**Infective and Parasitic**	**Infective and Parasitic Diseases**
250	Diabetes	Diabetes Mellitus
290, 331.0	Alzheimer's Disease	Alzheimer's Disease(including senile and pre-senile dementia)
390-459		**Circulatory Disease**
401-405		*Hypertensive Disease (equivalent code available 1969 on only)*
410-414,429.2		*Ischemic Heart Disease*
430-438	*Stroke*	*Cerebrovascular Disease*
440-448		*Diseases of Arteries, Arterioles and Capillaries*
460-519		**Respiratory Disease**
487		*Influenza*
480-486		*Pneumonia*
490-493,496		*Chronic Obstructive Pulmonary Disease (Bronchitis, Emphysema, and Asthma)*
531-534		Ulcers
571	Cirrhosis	Cirrhosis of liver
580-593		Kidney Diseases
740-759		**Congenital Anomalies**
760-779		**Perinatal Mortality**
E800-E999	**Accidents**	**Accidents/Poisonings/Violence**
E810-E819	*MVTA*	*Motor Vehicle Traffic Accidents*
E880-E888, E929.3	*Falls*	*Accidental Falls*
E890-E899, E929.4		*Fires*
E830, E832, E910		*Drowning*
E950-E959		*Suicide*
E960-E969		*Homicide*

World Health Organization, Manual of the International Statistical Classification of Diseases, Injuries and Causes of Death, Vol. 1 (Tabular List) and Vol. II (Index), 1975 Revision. WHO, Geneva, 1977. Equivalences used for ICD 6th to 8th revision available upon request.

Table 1. Risk Estimates by Cancer Site with Regard to the Carcinogenic Influence of Radiation

Cancer Site	Relative Risk at 1 Gy	Excess Risk x 10^4 PY-Gy	Comment
Cancers Frequently Associated with Radiation with Authoritative Risk Estimates			
Leukemia	1.3-6.2	0.5-2.9	Especially myeloid leukemia
Thyroid	1.6-31	3.0-13	Low mortality
Female Breast	1.1-2.7	3.5-18	Little risk if exposed over age 40
Cancers Occasionally Associated with Radiation with Valid Risk Estimates			
Lung	1.0-1.6	0.0-1.7	Interaction with smoking uncertain
Stomach	1.0-1.7	0.0-4.7	Major A-bomb effect
Colon	1.0-1.9	0.0-3.0	Not seen after cervical cancer
Esophagus	1.3-1.6	0.3-0.5	
Bladder	1.1-2.3	0.1-1.0	Both low and high dose effect
Ovary	1.0-2.3	0.1-0.7	
Myeloma	1.1-3.3	0.0-0.3	Uncertainty if association causal
Cancers Rarely Associated with Radiation with Uncertain Risk Estimates			
Brain and nervous system	1.0-5.9	0.0-1.1	Mainly after childhood exposures
Kidney	1.0-1.7	0.0-1.1	
Liver	1.0-1.5	0.0-1.6	Major Thorotrast effect
Salivary glands	1.1-1.7	0.1-0.2	Little evidence
Non-Hodgkin's lymphoma	not available	not available	Little evidence, possible high dose effect
Skin	1.0-2.0	0.1-2.5	Effect may be limited to high doses (or UV necessary)
Rectum	1.0-1.2	0.0-0.1	Effect may be limited to high doses
Uterus	1.0-1.01	0.0-0.5	Effect may be limited to high doses
Bone	1.0-1.1	0.0-0.1	Effect may be limited to high doses
Connective tissues	not available	not available	Effect may be limited to high doses

Ref: Boice (1996)

Table 2. Results of Residence Validation, Port Hope 1956-1997, Number of Deaths (Percent)

Classification	1956-1965	1966-1975	1976-1985	1986-1997	Total
Total	827 (100.0)	942 (100.0)	1058 (100.0)	1569 (100.0)	4396 (100.0)
minus: Specified Address Outside Town Boundary, Rural Route, Concession, Lot	3 (0.4)	2 (0.2)	8 (0.8)	84 (5.4)	97 (2.2)
Present Analysis	824 (99.6)	940 (99.8)	1050 (99.2)	1485 (94.6)	4299 (97.8)
Remaining Uncertain: Post Office Box, Unknown address or street crosses boundary	15 (1.8)	10 (1.1)	4 (0.4)	10 (0.6)	39 (0.9)

Table 3a. Cancer Mortality for Males in Port Hope by Period, Cancer Sites of *a priori* interest, All Ages

Cancer Site	Period	Deaths	Expected	S.M.R.	S.M.R. Flag	95% Confidence Interval Lower - Upper
All cancers						
	1956-1965	72	64.5	1.12		(0.87 - 1.41)
	1966-1975	75	83.9	0.89		(0.70 - 1.12)
	1976-1985	112	112.5	1.00		(0.82 - 1.20)
	1986-1997	164	167.9	0.98		(0.83 - 1.14)
	1956-1997	423	428.7	0.99		(0.89 - 1.09)
Lung						
	1956-1965	16	12.6	1.27		(0.73 - 2.05)
	1966-1975	21	22.8	0.92		(0.57 - 1.41)
	1976-1985	36	35.4	1.02		(0.71 - 1.41)
	1986-1997	48	50.0	0.96		(0.71 - 1.27)
	1956-1997	121	120.8	1.00		(0.83 - 1.20)
Breast						
	1956-1965	<5		<1.00		
	1966-1975	<5		<1.00		
	1976-1985	<5		<1.00		
	1986-1997	<5		<1.00		
	1956-1997	<5		<1.00		
Leukemia						
	1956-1965	<5		>1.00		
	1966-1975	<5		<1.00		
	1976-1985	<5		<1.00	-	
	1986-1997	5	6.4	0.78		(0.25 - 1.79)
	1956-1997	11	17.4	0.63		(0.32 - 1.12)

Legend

Standardized mortality ratio (S.M.R.) Flag

++ Significantly high, p-value < 0.01

\+ Significantly high, p-value < 0.05

Blank - not significant

\- Significantly low, p-value < 0.05

-- Significantly low, p-value < 0.01

Notes: NA indicates total suppressed because a component is less than 5.

Table 3b. Cancer Mortality for Females in Port Hope by Period, Cancer Sites of *a priori* interest, All Ages

Cancer Site	Period	Deaths	Expected	S.M.R.	S.M.R. Flag	95% Confidence Interval Lower - Upper
All cancers						
	1956-1965	61	65.8	0.93		(0.71 - 1.19)
	1966-1975	73	81.8	0.89		(0.70 - 1.12)
	1976-1985	104	108.2	0.96		(0.79 - 1.16)
	1986-1997	175	160.1	1.09		(0.94 - 1.27)
	1956-1997	413	415.9	0.99		(0.90 - 1.09)
Lung						
	1956-1965	<5		>1.00		
	1966-1975	6	5.1	1.19		(0.44 - 2.55)
	1976-1985	11	12.8	0.86		(0.43 - 1.53)
	1986-1997	36	28.2	1.28		(0.89 - 1.77)
	1966-1997[1]	53	46.1	1.15		(0.86 - 1.50)
Breast						
	1956-1965	14	13.3	1.06		(0.58 - 1.77)
	1966-1975	16	16.2	0.99		(0.56 - 1.60)
	1976-1985	21	20.7	1.01		(0.63 - 1.55)
	1986-1997	29	30.1	0.96		(0.65 - 1.38)
	1956-1997	80	80.3	1.00		(0.79 - 1.24)
Leukemia						
	1956-1965	<5		<1.00		
	1966-1975	<5		>1.00		
	1976-1985	<5		<1.00		
	1986-1997	5	5.6	0.89		(0.29 - 2.04)
	1956-1997	13	15.3	0.85		(0.45 - 1.45)

Legend

Standardized mortality ratio (S.M.R.) Flag

++ Significantly high, p-value < 0.01

\+ Significantly high, p-value < 0.05

Blank - not significant

\- Significantly low, p-value < 0.05

-- Significantly low, p-value < 0.01

Notes: NA indicates total suppressed because a component is less than 5.

[1] Deaths for 1966-1997 presented to avoid residual disclosure of a table cell less than 5

Table 3c. Cancer Mortality for Males and Females in Port Hope by Period, Cancer Sites of *a priori* interest, All Ages

Cancer Site	Period	Deaths	Expected	S.M.R.	S.M.R. Flag	95% Confidence Interval Lower - Upper
All cancers						
	1956-1965	133	130.3	1.02		(0.86 - 1.21)
	1966-1975	148	165.6	0.89		(0.76 - 1.05)
	1976-1985	216	220.6	0.98		(0.85 - 1.12)
	1986-1997	339	328.0	1.03		(0.93 - 1.15)
	1956-1997	836	844.6	0.99		(0.92 - 1.06)
Lung						
	1956-1965	NA		>1.00		
	1966-1975	27	27.8	0.97		(0.64 - 1.41)
	1976-1985	47	48.2	0.97		(0.72 - 1.30)
	1986-1997	84	78.2	1.07		(0.86 - 1.33)
	1966-1997[1]	158	154.2	1.02		(0.87 - 1.20)
Breast						
	1956-1965	14	13.3	1.05		(0.57 - 1.76)
	1966-1975	16	16.3	0.98		(0.56 - 1.59)
	1976-1985	21	20.9	1.01		(0.62 - 1.54)
	1986-1997	29	30.3	0.96		(0.64 - 1.38)
	1956-1997	80	80.8	0.99		(0.79 - 1.23)
Leukemia						
	1956-1965	NA		<1.00		
	1966-1975	7	6.8	1.03		(0.41 - 2.10)
	1976-1985	<5		<1.00	-	
	1986-1997	10	12.1	0.83		(0.40 - 1.52)
	1956-1997	24	32.7	0.73		(0.47 - 1.09)

Legend

Standardized mortality ratio (S.M.R.) Flag

++ Significantly high, p-value < 0.01

\+ Significantly high, p-value < 0.05

Blank - not significant

\- Significantly low, p-value < 0.05

-- Significantly low, p-value < 0.01

Notes: NA indicates total suppressed because a component is less than 5.

[1] Deaths for 1966-1997 presented to avoid residual disclosure of a table cell less than 5

Table 4. Childhood Cancer Mortality in Port Hope 1956-1997, Selected Cancer Sites, Males and Females, Ages 0-19

Cancer Site	Deaths	Expected	S.M.R.	S.M.R. Flag	95% Confidence Interval Lower - Upper
All cancers	11	7.4	1.48		(0.74 - 2.65)
Brain and nervous system	<5		>1.00		
Non-Hodgkin's lymphoma	<5		>1.00		
Leukemia	5	3.1	1.63		(0.53 - 3.81)

Legend

Standardized mortality ratio (S.M.R.) Flag

++ Significantly high, p-value < 0.01

\+ Significantly high, p-value < 0.05

Blank - not significan

\- Significantly low, p-value < 0.0

-- Significantly low, p-value < 0.0

Table 5a. Mortality for Males in Port Hope by Period,
All Causes and Causes Significantly Different from Province, All Ages

Cause	Period	Deaths	Expected	S.M.R.	S.M.R. Flag	95% Confidence Interval Lower - Upper
All causes						
	1956-1965	453	412.8	1.10		(1.00 - 1.20)
	1966-1975	495	448.7	1.10	+	(1.01 - 1.20)
	1976-1985	547	490.4	1.12	+	(1.02 - 1.21)
	1986-1997	685	628.2	1.09	+	(1.01 - 1.18)
	1956-1997	2180	1980.0	1.10	++	(1.06 - 1.15)
Esophageal cancer						
	1956-1965	<5		>1.00		
	1966-1975	<5		>1.00		
	1976-1985	7	2.8	2.48		(1.00 - 5.06)
	1986-1997	<5		<1.00		
	1956-1997	17	11.2	1.52		(0.89 - 2.44)
Brain cancer						
	1956-1965	<5		>1.00		
	1966-1975	<5		>1.00		
	1976-1985	<5		<1.00		
	1986-1997	<5		<1.00		
	1956-1997	11	10.7	1.03		(0.52 - 1.84)
Circulatory disease						
	1956-1965	254	225.8	1.12		(0.99 - 1.27)
	1966-1975	281	235.4	1.19	++	(1.06 - 1.34)
	1976-1985	277	238.8	1.16	+	(1.03 - 1.30)
	1986-1997	300	250.0	1.20	++	(1.07 - 1.34)
	1956-1997	1112	950.1	1.17	++	(1.10 - 1.24)
Ischemic heart disease						
	1956-1965	162	143.1	1.13		(0.96 - 1.32)
	1966-1975	197	164.1	1.20	+	(1.04 - 1.38)
	1976-1985	187	165.3	1.13		(0.98 - 1.31)
	1986-1997	180	161.8	1.11		(0.96 - 1.29)
	1956-1997	726	634.3	1.14	++	(1.06 - 1.23)
Cerebrovascular disease						
	1956-1965	49	42.5	1.15		(0.85 - 1.53)
	1966-1975	44	39.6	1.11		(0.81 - 1.49)
	1976-1985	43	36.7	1.17		(0.85 - 1.58)
	1986-1997	46	40.8	1.13		(0.83 - 1.51)
	1956-1997	182	159.5	1.14		(0.98 - 1.32)
Diseases of the arteries						
	1956-1965	13	9.8	1.33		(0.71 - 2.27)
	1966-1975	12	14.0	0.86		(0.44 - 1.49)
	1976-1985	21	16.7	1.26		(0.78 - 1.92)
	1986-1997	38	17.8	2.14	++	(1.52 - 2.94)
	1956-1997	84	58.2	1.44	++	(1.15 - 1.79)
Pneumonia						
	1956-1965	20	15.5	1.29		(0.79 - 1.99)
	1966-1975	19	15.9	1.19		(0.72 - 1.86)
	1976-1985	21	15.2	1.38		(0.85 - 2.11)
	1986-1997	38	22.5	1.69	++	(1.19 - 2.31)
	1956-1997	98	69.3	1.41	++	(1.15 - 1.72)
Cirrhosis						
	1956-1965	<5		>1.00		
	1966-1975	9	6.7	1.34		(0.61 - 2.53)
	1976-1985	15	8.1	1.86	+	(1.04 - 3.07)
	1986-1997	6	8.5	0.71		(0.26 - 1.52)
	1956-1997	NA		>1.00		

Legend/Notes: See Table 3a

Table 5b. Mortality for Females in Port Hope by Period,
All Causes and Causes Significantly Different from Province, All Ages

Cause	Period	Deaths	Expected	S.M.R.	S.M.R. Flag	95% Confidence Interval Lower - Upper
All causes						
	1956-1965	371	382.8	0.97		(0.87 - 1.07)
	1966-1975	445	432.7	1.03		(0.94 - 1.13)
	1976-1985	503	502.0	1.00		(0.92 - 1.09)
	1986-1997	800	687.1	1.16	++	(1.09 - 1.25)
	1956-1997	2119	2004.7	1.06	+	(1.01 - 1.10)
Esophageal cancer						
	1956-1965	<5		<1.00		
	1966-1975	<5		>1.00		
	1976-1985	<5		>1.00		
	1986-1997	<5		<1.00		
	1956-1997	6	5.9	1.02		(0.38 - 2.20)
Brain cancer						
	1956-1965	<5		<1.00		
	1966-1975	<5		>1.00		
	1976-1985	<5		<1.00		
	1986-1997	8	3.3	2.39	+	(1.03 - 4.67)
	1956-1997	13	8.9	1.47		(0.78 - 2.50)
Circulatory disease						
	1956-1965	224	223.4	1.00		(0.88 - 1.14)
	1966-1975	260	249.5	1.04		(0.92 - 1.18)
	1976-1985	289	270.7	1.07		(0.95 - 1.20)
	1986-1997	416	305.8	1.36	++	(1.23 - 1.50)
	1956-1997	1189	1049.4	1.13	++	(1.07 - 1.20)
Ischemic heart disease						
	1956-1965	107	108.2	0.99		(0.81 - 1.20)
	1966-1975	159	147.0	1.08		(0.92 - 1.26)
	1976-1985	182	162.3	1.12		(0.96 - 1.30)
	1986-1997	216	168.5	1.28	++	(1.12 - 1.46)
	1956-1997	664	585.9	1.13	++	(1.05 - 1.22)
Cerebrovascular disease						
	1956-1965	65	62.1	1.05		(0.81 - 1.33)
	1966-1975	57	60.5	0.94		(0.71 - 1.22)
	1976-1985	52	60.6	0.86		(0.64 - 1.12)
	1986-1997	94	70.4	1.34	++	(1.08 - 1.63)
	1956-1997	268	253.6	1.06		(0.93 - 1.19)
Diseases of the arteries						
	1956-1965	9	10.9	0.82		(0.38 - 1.55)
	1966-1975	16	17.7	0.90		(0.52 - 1.47)
	1976-1985	27	21.8	1.24		(0.82 - 1.80)
	1986-1997	63	24.3	2.60	++	(2.00 - 3.32)
	1956-1997	115	74.7	1.54	++	(1.27 - 1.85)
Pneumonia						
	1956-1965	15	15.6	0.96		(0.54 - 1.59)
	1966-1975	21	17.4	1.21		(0.75 - 1.84)
	1976-1985	29	18.2	1.59	+	(1.07 - 2.28)
	1986-1997	39	30.3	1.29		(0.92 - 1.76)
	1956-1997	104	81.6	1.27	+	(1.04 - 1.54)
Cirrhosis						
	1956-1965	<5		<1.00		
	1966-1975	6	3.8	1.56		(0.57 - 3.35)
	1976-1985	5	4.4	1.15		(0.37 - 2.63)
	1986-1997	5	4.4	1.13		(0.37 - 2.59)
	1956-1997	NA		>1.00		

Legend/Notes: See Table 3a

Table 5c. Mortality for Males and Females in Port Hope by Period, All Causes and Causes Significantly Different from Province, All Ages

Cause	Period	Deaths	Expected	S.M.R.	S.M.R. Flag	95% Confidence Interval Lower - Upper
All causes						
	1956-1965	824	795.5	1.04		(0.97 - 1.11)
	1966-1975	940	881.4	1.07		(1.00 - 1.14)
	1976-1985	1050	992.4	1.06		(1.00 - 1.12)
	1986-1997	1485	1315.3	1.13	++	(1.07 - 1.19)
	1956-1997	4299	3984.7	1.08	++	(1.05 - 1.11)
Esophageal cancer						
	1956-1965	<5		<1.00		
	1966-1975	6	3.2	1.86		(0.68 - 3.99)
	1976-1985	NA		>1.00	+	
	1986-1997	5	7.0	0.72		(0.23 - 1.64)
	1956-1997	23	17.0	1.35		(0.86 - 2.03)
Brain cancer						
	1956-1965	<5		>1.00		
	1966-1975	6	3.9	1.52		(0.56 - 3.27)
	1976-1985	<5		<1.00		
	1986-1997	NA		>1.00		
	1956-1997	24	19.5	1.23		(0.79 - 1.83)
Circulatory disease						
	1956-1965	478	449.2	1.06		(0.97 - 1.16)
	1966-1975	541	484.9	1.12	+	(1.02 - 1.21)
	1976-1985	566	509.5	1.11	+	(1.02 - 1.21)
	1986-1997	716	555.9	1.29	++	(1.20 - 1.39)
	1956-1997	2301	1999.5	1.15	++	(1.10 - 1.20)
Ischemic heart disease						
	1956-1965	269	251.3	1.07		(0.95 - 1.21)
	1966-1975	356	311.1	1.14	+	(1.03 - 1.27)
	1976-1985	369	327.6	1.13	+	(1.01 - 1.25)
	1986-1997	396	330.4	1.20	++	(1.08 - 1.32)
	1956-1997	1390	1220.2	1.14	++	(1.08 - 1.20)
Cerebrovascular disease						
	1956-1965	114	104.6	1.09		(0.90 - 1.31)
	1966-1975	101	100.1	1.01		(0.82 - 1.23)
	1976-1985	95	97.3	0.98		(0.79 - 1.19)
	1986-1997	140	111.2	1.26	++	(1.06 - 1.49)
	1956-1997	450	413.1	1.09		(0.99 - 1.19)
Diseases of the arteries						
	1956-1965	22	20.7	1.06		(0.67 - 1.61)
	1966-1975	28	31.7	0.88		(0.59 - 1.28)
	1976-1985	48	38.5	1.25		(0.92 - 1.65)
	1986-1997	101	42.0	2.40	++	(1.96 - 2.92)
	1956-1997	199	132.9	1.50	++	(1.30 - 1.72)
Pneumonia						
	1956-1965	35	31.1	1.13		(0.78 - 1.57)
	1966-1975	40	33.4	1.20		(0.86 - 1.63)
	1976-1985	50	33.5	1.49	++	(1.11 - 1.97)
	1986-1997	77	52.9	1.46	++	(1.15 - 1.82)
	1956-1997	202	150.8	1.34	++	(1.16 - 1.54)
Cirrhosis						
	1956-1965	5	6.2	0.81		(0.26 - 1.85)
	1966-1975	15	10.6	1.42		(0.80 - 2.34)
	1976-1985	20	12.4	1.61		(0.99 - 2.49)
	1986-1997	11	12.9	0.85		(0.43 - 1.52)
	1956-1997	51	42.1	1.21		(0.90 - 1.59)

Legend/Notes: See Table 3a

Table 6a. Mortality in Port Hope, Males, 1956 to 1997

Cause of Death	Deaths	Expected	SMR	SMR Flag	95% Confidence Interval	P-value trend
All Causes	2180	1980.0	1.10	++	(1.06 - 1.15)	0.928
Infective & Parasitic Diseases	13	18.7	0.69		(0.37 - 1.18)	0.062
All Cancer Sites	423	428.7	0.99		(0.89 - 1.09)	0.631
Lip	<5		<1.00			
Tongue, Gum, Mouth, Pharynx ex. Nasopharynx	11	8.9	1.24		(0.62 - 2.21)	0.991
Salivary Gland	<5		>1.00			
Nasopharynx	<5		<1.00			
Esophagus	17	11.2	1.52		(0.89 - 2.44)	0.456
Stomach	18	28.2	0.64		(0.38 - 1.01)	0.784
Small Intestine including Duodenum	<5		>1.00			
Colon & Rectum	64	60.8	1.05		(0.81 - 1.34)	0.352
Liver	<5		<1.00			
Gallbladder	<5		>1.00			
Pancreas	22	21.6	1.02		(0.64 - 1.54)	0.546
Peritoneum	<5		<1.00			
Nose/Sinuses	<5		<1.00			
Larynx	5	5.3	0.94		(0.30 - 2.15)	0.832
Trachea, Bronchus, Lung	121	120.8	1.00		(0.83 - 1.20)	0.535
Pleura (1966-1997)	<5		<1.00			
Thymus, Heart & Mediastinum (1966-1997)	<5		>1.00			
Bone	<5		>1.00			
Connective Tissue	<5		<1.00			
Malignant Melanoma	<5		<1.00			
Breast	<5		<1.00			
Cervix Uteri						
Uterus excluding Cervix						
Ovary						
Other Female Genital Organs						
Prostate	54	47.3	1.14		(0.86 - 1.49)	0.851
Testis	<5		>1.00			
Other Male Genital Organs	<5		<1.00			
Bladder	17	15.9	1.07		(0.62 - 1.70)	0.286
Kidney & Other Urinary	12	9.3	1.28		(0.67 - 2.24)	0.543
Eye	<5		<1.00			
Brain & Other Nervous System	11	10.7	1.03		(0.52 - 1.84)	0.103
Thyroid	<5		<1.00			
Other Endocrine	<5		>1.00			
Ill-Defined & Unknown Site	21	19.5	1.08		(0.67 - 1.65)	0.142
Hodgkin's Disease	<5		<1.00			
Non-Hodgkin's Lymphoma	9	12.7	0.71		(0.33 - 1.34)	0.965
Multiple Myeloma	<5		<1.00			
Leukemia	11	17.4	0.63		(0.32 - 1.12)	0.568

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Table 6a (continued). Mortality in Port Hope, Males, 1956 to 1997

Cause of Death	Deaths	Expected	SMR	SMR Flag	95% Confidence Interval	P-value trend
Alzheimer's Disease (senile and pre-senile)	5	12.3	0.41	-	(0.13 - 0.93)	0.106
Circulatory Disease	1112	950.1	1.17	++	(1.10 - 1.24)	0.546
Hypertensive Disease (1969-1997)	16	7.9	2.03	+	(1.16 - 3.29)	0.014
Ischemic Heart Disease	726	634.3	1.14	++	(1.06 - 1.23)	0.715
Cerebrovascular Disease	182	159.5	1.14		(0.98 - 1.32)	0.981
Diseases of Arteries, Arterioles & Capillaries	84	58.2	1.44	++	(1.15 - 1.79)	0.020
Respiratory Disease	198	159.6	1.24	++	(1.07 - 1.43)	0.263
Influenza	6	3.8	1.60		(0.59 - 3.43)	0.104
Pneumonia	98	69.3	1.41	++	(1.15 - 1.72)	0.232
Chronic Obstructive Pulmonary Disease	74	69.9	1.06		(0.83 - 1.33)	0.078
Ulcers	7	10.9	0.64		(0.26 - 1.31)	0.633
Cirrhosis of Liver (1966-1997)[1]	30	23.3	1.29		(0.87 - 1.84)	0.525
Kidney Diseases	24	21.4	1.12		(0.72 - 1.67)	0.054
Congenital Anomalies	16	15.4	1.04		(0.60 - 1.69)	0.521
Perinatal Mortality	35	28.1	1.25		(0.87 - 1.74)	0.057
Accidents/Poisonings/Violence	149	150.7	0.99		(0.84 - 1.16)	0.513
Motor Vehicle Traffic Accidents	48	46.6	1.03		(0.76 - 1.37)	0.474
Accidental Falls	26	21.1	1.23		(0.81 - 1.81)	0.799
Fires	<5		<1.00			
Drownings	12	10.1	1.19		(0.62 - 2.08)	0.574
Suicide	33	32.5	1.01		(0.70 - 1.42)	0.765
Homicide	<5		<1.00			

Legend/Notes: See also Table 3a

[1] Deaths for 1966-1997 presented to avoid residual disclosure of a table cell less than 5

Table 6b. Mortality in Port Hope, Females, 1956 to 1997

Cause of Death	Deaths	Expected	SMR	SMR Flag	95% Confidence Interval	P-value trend
All Causes	2119	2004.7	1.06	+	(1.01 - 1.10)	0.003
Infective & Parasitic Diseases	9	13.0	0.69		(0.32 - 1.31)	0.012
All Cancer Sites	413	415.9	0.99		(0.90 - 1.09)	0.139
Lip	<5		<1.00			
Tongue, Gum, Mouth, Pharynx ex. Nasopharynx	<5		<1.00			
Salivary Gland	<5		>1.00			
Nasopharynx	<5		<1.00			
Esophagus	6	5.9	1.02		(0.38 - 2.20)	0.899
Stomach	17	20.4	0.83		(0.49 - 1.33)	0.904
Small Intestine including Duodenum	<5		<1.00			
Colon & Rectum	72	72.0	1.00		(0.78 - 1.26)	0.118
Liver	<5		<1.00			
Gallbladder	5	7.7	0.65		(0.21 - 1.48)	0.035
Pancreas	18	22.1	0.81		(0.48 - 1.29)	0.959
Peritoneum	<5		<1.00			
Nose/Sinuses	<5		<1.00			
Larynx	<5		<1.00			
Trachea, Bronchus, Lung (1966-1997) [1]	53	46.1	1.15		(0.86 - 1.50)	0.928
Pleura (1966-1997)	<5		<1.00			
Thymus, Heart & Mediastinum (1966-1997)	<5		<1.00			
Bone	<5		<1.00			
Connective Tissue	<5		>1.00			
Malignant Melanoma	5	3.5	1.45		(0.47 - 3.32)	0.351
Breast	80	80.3	1.00		(0.79 - 1.24)	0.807
Cervix Uteri	6	12.8	0.47		(0.17 - 1.01)	0.439
Uterus excluding Cervix	16	11.5	1.39		(0.79 - 2.25)	0.624
Ovary	19	24.1	0.79		(0.48 - 1.23)	0.749
Other Female Genital Organs	<5		>1.00			
Prostate						
Testis						
Other Male Genital Organs						
Bladder	10	8.3	1.20		(0.58 - 2.20)	0.419
Kidney & Other Urinary	7	6.4	1.09		(0.44 - 2.23)	0.578
Eye	<5		<1.00			
Brain & Other Nervous System	13	8.9	1.47		(0.78 - 2.50)	0.099
Thyroid	<5		<1.00			
Other Endocrine	<5		<1.00			
Ill-Defined & Unknown Site	27	22.1	1.22		(0.81 - 1.78)	0.839
Hodgkin's Disease	<5		<1.00			
Non-Hodgkin's Lymphoma	18	12.9	1.40		(0.83 - 2.20)	0.960
Multiple Myeloma	<5		<1.00			
Leukemia	13	15.3	0.85		(0.45 - 1.45)	0.812

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Table 6b (continued). Mortality in Port Hope, Females, 1956 to 1997

Cause of Death	Deaths	Expected	SMR	SMR Flag	95% Confidence Interval	P-value trend
Diabetes	22	45.2	0.49	--	(0.31 - 0.74)	0.292
Alzheimer's Disease (senile and pre-senile)	17	25.2	0.67		(0.39 - 1.08)	0.765
Circulatory Disease	1189	1049.4	1.13	++	(1.07 - 1.20)	0.000
Hypertensive Disease (1969-1997)	22	13.0	1.69	+	(1.06 - 2.55)	0.343
Ischemic Heart Disease	664	585.9	1.13	++	(1.05 - 1.22)	0.022
Cerebrovascular Disease	268	253.6	1.06		(0.93 - 1.19)	0.135
Diseases of Arteries, Arterioles & Capillaries	115	74.7	1.54	++	(1.27 - 1.85)	0.000
Respiratory Disease	158	135.3	1.17		(0.99 - 1.36)	0.326
Influenza	7	5.4	1.31		(0.53 - 2.67)	0.007
Pneumonia	104	81.6	1.27	+	(1.04 - 1.54)	0.334
Chronic Obstructive Pulmonary Disease	36	33.8	1.06		(0.75 - 1.47)	0.370
Ulcers	5	7.7	0.65		(0.21 - 1.50)	0.802
Cirrhosis of Liver (1966-1997)[1]	16	12.6	1.27		(0.73 - 2.05)	0.667
Kidney Diseases	18	22.8	0.79		(0.47 - 1.25)	0.419
Congenital Anomalies	10	14.3	0.70		(0.34 - 1.28)	0.519
Perinatal Mortality	16	20.2	0.79		(0.45 - 1.29)	0.727
Accidents/Poisonings/Violence	83	87.1	0.95		(0.76 - 1.18)	0.047
Motor Vehicle Traffic Accidents	22	20.5	1.07		(0.67 - 1.63)	0.407
Accidental Falls	32	31.9	1.00		(0.69 - 1.42)	0.019
Fires	<5		<1.00			
Drownings	<5		<1.00			
Suicide	5	12.4	0.40	-	(0.13 - 0.92)	0.515
Homicide	<5		>1.00			

Legend/Notes: See also Table 3a

[1] Deaths for 1966-1997 presented to avoid residual disclosure of a table cell less than 5

Table 6c. Mortality in Port Hope, Males and Females, 1956 to 1997

Cause of Death	Deaths	Expected	SMR	SMR Flag	95% Confidence Interval	P-value trend
All Causes	4299	3984.7	1.08	++	(1.05 - 1.11)	0.049
Infective & Parasitic Diseases	22	31.8	0.69		(0.43 - 1.05)	0.002
All Cancer Sites	836	844.6	0.99		(0.92 - 1.06)	0.482
Lip	<5		<1.00			
Tongue, Gum, Mouth, Pharynx ex. Nasopharynx	NA		<1.00			0.983
Salivary Gland	<5		>1.00			
Nasopharynx	<5		<1.00			
Esophagus	23	17.0	1.35		(0.86 - 2.03)	0.499
Stomach	35	48.6	0.72		(0.50 - 1.00)	0.904
Small Intestine including Duodenum	<5		>1.00			
Colon & Rectum	136	132.8	1.02		(0.86 - 1.21)	0.074
Liver	<5		<1.00			
Gallbladder	NA		<1.00			0.861
Pancreas	40	43.7	0.91		(0.65 - 1.25)	0.654
Peritoneum	<5		<1.00			
Nose/Sinuses	<5		<1.00			
Larynx	NA		<1.00			0.870
Trachea, Bronchus, Lung (1966-1997) [1]	158	154.2	1.02		(0.87 - 1.20)	0.697
Pleura (1966-1997)	<5		<1.00			
Thymus, Heart & Mediastinum (1966-1997)	<5		>1.00			
Bone	<5		>1.00			
Connective Tissue	<5		<1.00			
Malignant Melanoma	NA		>1.00			0.115
Breast	NA		<1.00			0.810
Cervix Uteri	6	12.8	0.47		(0.17 - 1.01)	0.439
Uterus excluding Cervix	16	11.5	1.39		(0.79 - 2.25)	0.624
Ovary	19	24.1	0.79		(0.48 - 1.23)	0.749
Other Female Genital Organs	<5		>1.00			
Prostate	54	47.3	1.14		(0.86 - 1.49)	0.851
Testis	<5		>1.00			
Other Male Genital Organs	<5		<1.00			
Bladder	27	24.3	1.11		(0.73 - 1.62)	0.717
Kidney & Other Urinary	19	15.7	1.21		(0.73 - 1.88)	0.888
Eye	<5		<1.00			
Brain & Other Nervous System	24	19.5	1.23		(0.79 - 1.83)	0.904
Thyroid	<5		<1.00			
Other Endocrine	<5		>1.00			
Ill-Defined & Unknown Site	48	41.6	1.15		(0.85 - 1.53)	0.403
Hodgkin's Disease	<5		<1.00			
Non-Hodgkin's Lymphoma	27	25.5	1.06		(0.70 - 1.54)	0.980
Multiple Myeloma	8	13.2	0.61		(0.26 - 1.19)	0.840
Leukemia	24	32.7	0.73		(0.47 - 1.09)	0.577

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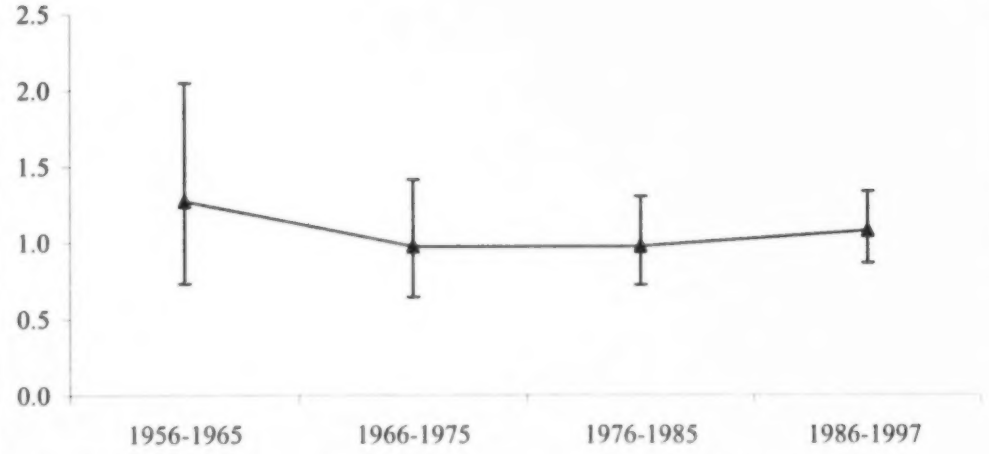
Table 6c (continued). Mortality in Port Hope, Males and Females, 1956 to 1997:

Cause of Death	Deaths	Expected	SMR	SMR Flag	95% Confidence Interval	P-value trend
Diabetes	42	77.0	0.55	--	(0.39 - 0.74)	0.319
Alzheimer's Disease (senile and pre-senile)	22	37.5	0.59	--	(0.37 - 0.89)	0.616
Circulatory Disease	2301	1999.5	1.15	++	(1.10 - 1.20)	0.001
Hypertensive Disease (1969-1997)	38	20.9	1.82	++	(1.29 - 2.49)	0.026
Ischemic Heart Disease	1390	1220.2	1.14	++	(1.08 - 1.20)	0.198
Cerebrovascular Disease	450	413.1	1.09		(0.99 - 1.19)	0.266
Diseases of Arteries, Arterioles & Capillaries	199	132.9	1.50	++	(1.30 - 1.72)	0.000
Respiratory Disease	356	294.9	1.21	++	(1.09 - 1.34)	0.144
Influenza	13	9.1	1.43		(0.76 - 2.43)	0.002
Pneumonia	202	150.8	1.34	++	(1.16 - 1.54)	0.138
Chronic Obstructive Pulmonary Disease	110	103.7	1.06		(0.87 - 1.28)	0.313
Ulcers	12	18.6	0.65		(0.33 - 1.12)	0.845
Cirrhosis of Liver	51	42.1	1.21		(0.90 - 1.59)	0.802
Kidney Diseases	42	44.1	0.95		(0.69 - 1.29)	0.328
Congenital Anomalies	26	29.6	0.88		(0.57 - 1.29)	0.369
Perinatal Mortality	51	48.3	1.06		(0.79 - 1.39)	0.088
Accidents/Poisonings/Violence	232	237.8	0.98		(0.85 - 1.11)	0.494
Motor Vehicle Traffic Accidents	70	67.0	1.04		(0.81 - 1.32)	0.898
Accidental Falls	58	53.0	1.09		(0.83 - 1.41)	0.052
Fires	6	9.4	0.64		(0.23 - 1.37)	0.731
Drownings	NA		>1.00			0.866
Suicide	38	45.0	0.85		(0.60 - 1.16)	0.644
Homicide	6	6.3	0.95		(0.35 - 2.04)	0.895

Legend/Notes: See also Table 3a

[1] Deaths for 1966-1997 presented to avoid residual disclosure of a table cell less than 5

Figure 1. Lung Cancer Mortality in Port Hope by Period, Males and Females, SMR with 95% CI



For 1956-1965 period results for males only shown since N<5 for females

Figure 2. Breast Cancer Mortality in Port Hope by Period, Females, SMR with 95% CI

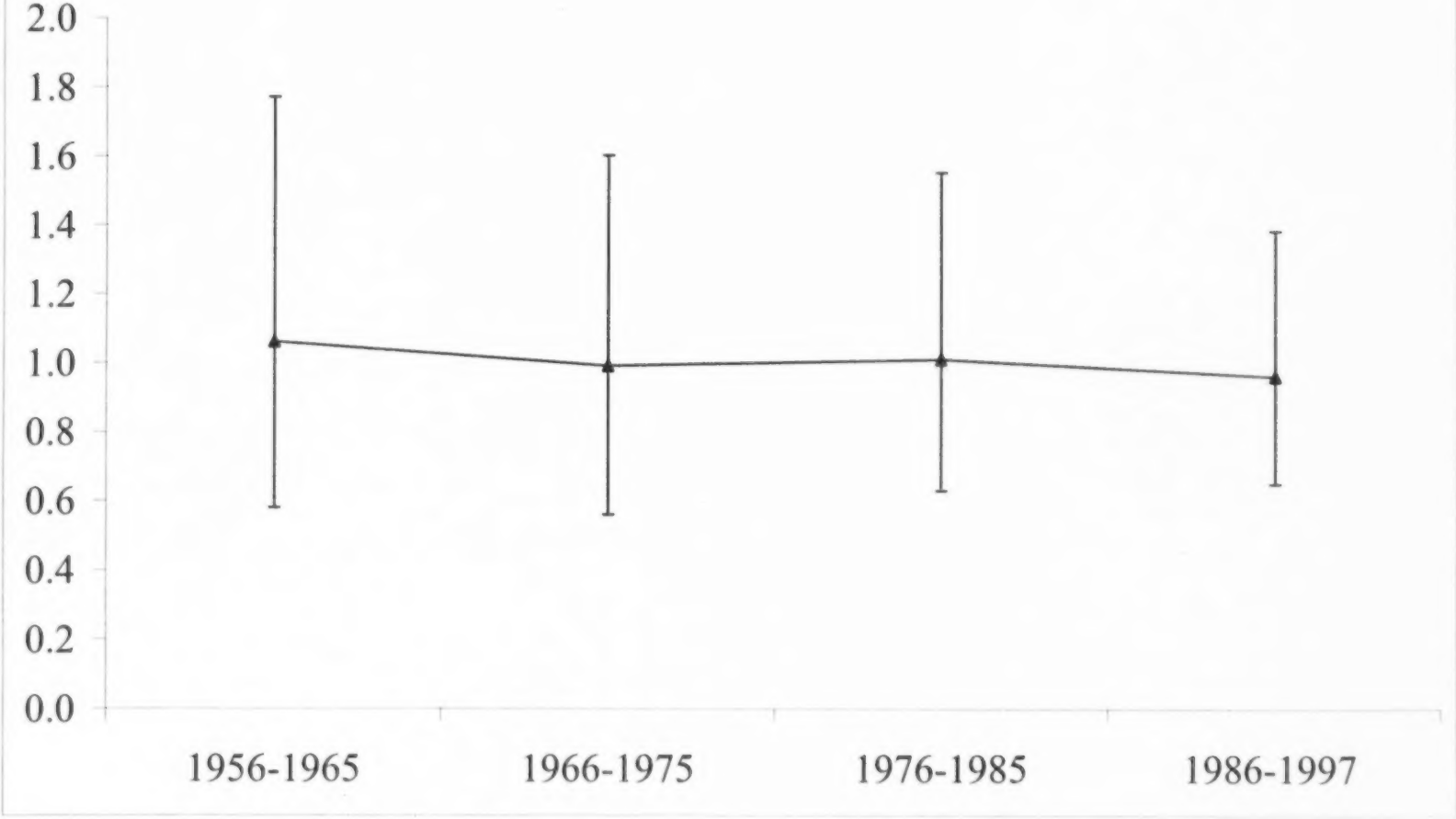


Figure 3. Leukemia Mortality in Port Hope by Period, Males and Females, SMR with 95% CI

For 1956-1965 SMR < 1.0 and for 1976-1985 period N<5 and SMR < 1.0

Figure 4. Circulatory Disease Mortality in Port Hope by Period, Males and Females, SMR with 95% CI

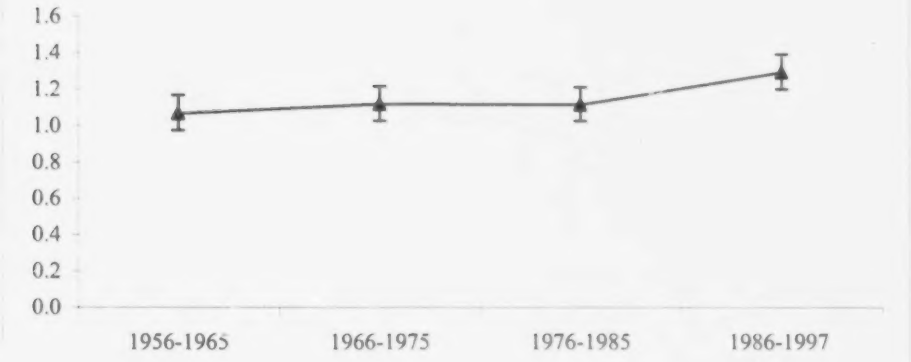


Table 7a. Incidence and Mortality for Males in Port Hope,
All Cancers and Sites Significantly Different from Province in Recent Period, All Ages

Cause	Outcome and Period	Number Observed	Expected	S.I.R./ S.M.R.	Flag	95% Confidence Interval Lower - Upper
All cancers						
	Incidence 1986-1996	275	295.4	0.93		(0.82 - 1.05)
	Mortality 1986-1997	164	167.9	0.98		(0.83 - 1.14)
Pharynx						
	Incidence 1986-1996	<5		<1.00		
	Mortality 1986-1997	<5		<1.00		
Esophageal cancer						
	Incidence 1986-1996	<5		<1.00		
	Mortality 1986-1997	<5		<1.00		
Colon & Rectum						
	Incidence 1986-1996	42	40.6	1.03		(0.75 - 1.40)
	Mortality 1986-1997	27	22.6	1.20		(0.79 - 1.74)
Liver						
	Incidence 1986-1996	<5		<1.00		
	Mortality 1986-1997	<5		<1.00		
Trachea, Bronchus, Lung						
	Incidence 1986-1996	57	54.1	1.05		(0.80 - 1.36)
	Mortality 1986-1997	48	50.0	0.96		(0.71 - 1.27)
Ovary						
	Incidence 1986-1996					
	Mortality 1986-1997					
Brain & Other Nervous System						
	Incidence 1986-1996	7	5.4	1.31		(0.53 - 2.67)
	Mortality 1986-1997	<5		<1.00		

Incidence results based on using postal code to assign residence
Legend/Other Notes: See Table 3a

Table 7b. Incidence and Mortality for Females in Port Hope,
All Cancers and Sites Significantly Different from Province in Recent Period, All Ages

Cause	Type and Period	Number Observed	Expected	S.I.R./ S.M.R.	Flag	95% Confidence Interval Lower - Upper
All cancers						
	Incidence 1986-1996	314	293.8	1.07		(0.95 - 1.19)
	Mortality 1986-1997	175	160.1	1.09		(0.94 - 1.27)
Pharynx						
	Incidence 1986-1996	5	1.2	4.17	+	(1.35 - 9.58)
	Mortality 1986-1997	<5		<1.00		
Esophageal cancer						
	Incidence 1986-1996	<5		>1.00		
	Mortality 1986-1997	<5		<1.00		
Colon & Rectum						
	Incidence 1986-1996	61	43.0	1.42	+	(1.09 - 1.82)
	Mortality 1986-1997	33	23.9	1.38		(0.95 - 1.94)
Liver						
	Incidence 1986-1996	<5		<1.00		
	Mortality 1986-1997	<5		<1.00		
Trachea, Bronchus, Lung						
	Incidence 1986-1996	44	32.7	1.35		(0.98 - 1.81)
	Mortality 1986-1997	36	28.2	1.28		(0.89 - 1.77)
Ovary						
	Incidence 1986-1996	5	11.6	0.43	-	(0.14 - 0.99)
	Mortality 1986-1997	5	8.2	0.61		(0.20 - 1.40)
Brain & Other Nervous System						
	Incidence 1986-1996	8	5.0	1.61		(0.70 - 3.15)
	Mortality 1986-1997	8	3.3	2.39	+	(1.03 - 4.67)

Incidence results based on using postal code to assign residence
Legend/Other Notes: See Table 3a